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PATENT ABSTRACTS OF JAPAN

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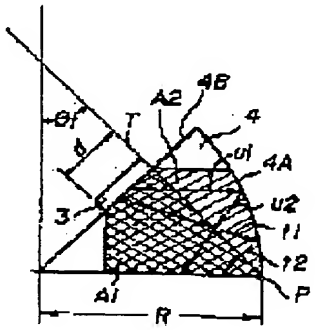
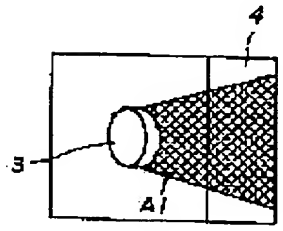
(71)Applicant : FUJI ELECTRIC CO LTD
(72)Inventor : HANAMIYA IKUO

(54) TRANSMISSIVE ULTRASONIC FLOWMETER

(57)Abstract:
PURPOSE: To enhance accuracy in measurement by enhancing directivity in the transmission of ultrasonic wave thereby enhancing S/N ratio of received wave.
CONSTITUTION: Transducer for transmissive ultrasonic flowmeter is constructed such that an ultrasonic oscillator is bonded to a wedge 4 having cross-section of split circle (or split ellipse). Consequently, reflected waves u2, t2 of radiated ultrasonic wave is prevented from impinging on the ultrasonic oscillator 3 and multiplex reflection of ultrasonic wave on the transducer is suppressed thus suppressing trailing of intruded wave and enhancing measurent accuracy.





LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] It has an ultrasonic vibrator and the wedge which this pastes up, and a location is mutually shifted to the skin of piping and opposite arrangement of one pair of transducers in which transmission of a supersonic wave and reception are possible is carried out. The propagation time of the acoustic wave from the ultrasonic vibrator of the upstream to the ultrasonic vibrator of the downstream, In the transparency type ultrasonic flowmeter which measures the rate of flow or flow rate of a fluid from a difference with the propagation time of the acoustic wave from the ultrasonic vibrator of the downstream to the ultrasonic vibrator of the upstream The transparency type ultrasonic flowmeter characterized by making the cross-section configuration of the direction of a piping major axis of the wedge at least in one side of one pair of said transducers into 1/several the shape of a division circle or a division ellipse.
[Claim 2] It has an ultrasonic vibrator and the wedge which this pastes up, and a location is mutually shifted to the skin of piping and opposite arrangement of one pair of transducers in which transmission of a supersonic wave and reception are possible is carried out. The propagation time of the acoustic wave from the ultrasonic vibrator of the upstream to the ultrasonic vibrator of the downstream, In the transparency type ultrasonic flowmeter which measures the rate of flow or flow rate of a fluid from a difference with the propagation time of the acoustic wave from the ultrasonic vibrator of the downstream to the ultrasonic vibrator of the upstream The transparency type ultrasonic flowmeter characterized by coming to give the point of the wedge at least in one side of one pair of said transducers a taper.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention discharges a supersonic wave in a fluid from a piping outer wall, receives by the piping skin, and relates to the transparency type ultrasonic flowmeter which makes it a principle for that travelling period to be proportional to the rate of flow or flow rate of a fluid, especially its amelioration.
[0002]
[Description of the Prior Art] Drawing 9 and drawing 10 are the schematic diagrams showing the conventional example of a transparency type ultrasonic flowmeter (it is also only called an ultrasonic flowmeter). What is shown in drawing 9 is the example which carried out opposite arrangement of ultrasonic transducer (only henceforth transducer) 2a which receives the supersonic wave which is discharged in a fluid and spreads the inside of a fluid, and the 2b mutually with a fixed distance through the sound coupling material 10 on the same line of the outer wall crowning of the piping 1 which leads a fluid. Moreover, what is shown in drawing 10 is the example which separated a fixed distance and carried out opposite arrangement mutually on the line by which the outer wall crownings of the piping 1 which leads a fluid differ transducer 2a which receives the supersonic wave which it is discharged in a fluid and reflected with a piping wall, and 2b through the sound coupling material 10.
[0003] As transducer 2a used by drawing 9 and drawing 10 , and 2b, as shown in drawing 11 , the ultrasonic vibrator 3 which is a piezoelectric device like PZT (Pb03 (Zr-Ti)) is pasted up on the block (only henceforth a wedge) 4 of the epoxy system resin generally used as ultrasonic transparency material, and it is constituted. Drawing 11 (b) is a sectional side elevation, and ** (b) is a plan. In such a configuration, since the time difference of time amount until the supersonic wave discharged from transducer 2a reaches transducer 2b, and time amount until the supersonic wave discharged from transducer 2b reaches transducer 2a is proportional to the rate of flow or flow rate of flowing fluid 20 about the inside of piping 1, it is the measurement principle of an ultrasonic flowmeter to measure the rate of flow or a flow rate from this time difference.
[0004]
[Problem(s) to be Solved by the Invention] However, usually it is superimposed on the supersonic wave (so-called surroundings lump wave) spread while reflecting multiply in the pipe-wall-thickness section as a noise in accordance with a piping inside-and-outside wall to the supersonic wave (direct wave-receiving) which spreads the inside of a fluid from one transducer, and is received by the transducer of another side in the above ultrasonic flowmeters. The effect of a surroundings [this] lump wave is explained below with reference to drawing 12 -15. As shown in drawing 12 and drawing 13 , the supersonic wave discharged with the ultrasonic vibrator 3 is spread as direct wave-receiving W, and the remainder is received by the transducer of another side which is not illustrated as the surroundings lump waves W1 and W2 and W3. The component of a surroundings lump wave is a mixture wave with wave W3 spread along with the wave W1 spread while it reflects multiply in the pipe thickness section, as shown in drawing 13 (b) and (b), the wave W2 spread along with the tubing skin 16, and the tubing internal surface 15.

Although there are tailing (that to which tailing of a wave has extended to the time domain of direct wave-receiving) of the wave received in the front time zone rather than direct wave-receiving, and a wave which spreads the periphery thick section of piping as a wave superimposed on direct wave-receiving among the surroundings lump waves of these, it turns out that it will decrease if the latter raises the directivity of transmission.

[0005] The relation between the direct wave-receiving Sr in drawing 9 and an ultrasonic flowmeter like drawing 10 and the surroundings lump wave Rr of piping received in the time zone before direct wave-receiving is shown in drawing 14 . Since tailing of the surroundings lump wave Rr of piping laps with the direct wave-receiving Sr as shown in this drawing, it is said that S/N of a received wave falls. Drawing 15 is an explanatory view for explaining the propagation mode of the supersonic wave (henceforth a sound ray) discharged from the ultrasonic vibrator in the conventional transducer, this drawing (b) is the sectional side elevation of an ultrasonic vibrator, and (b) is the plan. In this drawing, the placing include angle of the supersonic wave of the ultrasonic vibrator [as opposed to the vertical line of a piping straight side shaft in thetat] 3, the sound ray which discharged u and t from the ultrasonic vibrator 3 by a certain pointing angle to piping straight side shaft orientations, and d show the outer-diameter dimension of an ultrasonic vibrator 3, respectively.

[0006] That is, **** each sound rays u1, u2, u3, t1, t2, and t3 shown by the arrow head are near fields, and the big primary reflected wave of energy carries out incidence of them to an ultrasonic vibrator 3, and they turn into the sound rays u3 and t3 which go to transducer 2b of a receiving side. By the way, since whenever [to piping / incident angle] reflects multiply small these sound rays u3 and t3 between ultrasonic vibrators, they are in the inclination for tailing of a transmission wave to be prolonged. Thus, since a part of sound ray which carried out incidence to the field shown by A2 will go to transducer 2b of a receiving side, each field shown by A1, A2, and A3 after all will call it the field of the sound ray which goes to transducer 2b of a receiving side, and can say that it is easy to become the sound ray which forms tailing of a transmission wave. Thus, the measurement precision of a surroundings lump wave and the propagation time of direct wave-receiving which S/N of a received wave falls especially by the tailing, and is proportional to the rate of flow or flow rate of a fluid falls to the conventional thing, and there is a problem of exact measurement becoming impossible. Therefore, it is in the technical problem of this invention lessening the multiple echo of the supersonic wave within a transducer, decreasing tailing of a surroundings lump wave, and raising measurement precision while it raises the directivity of transmission.

[0007]

[Means for Solving the Problem] In order to solve such a technical problem, in the 1st invention It has an ultrasonic vibrator and the wedge which this pastes up, and a location is mutually shifted to the skin of piping and opposite arrangement of one pair of transducers in which transmission of a supersonic wave and reception are possible is carried out. The propagation time of the acoustic wave from the ultrasonic vibrator of the upstream to the ultrasonic vibrator of the downstream, In the transparency type ultrasonic flowmeter which measures the rate of flow or flow rate of a fluid from a difference with the propagation time of the acoustic wave from the ultrasonic vibrator of the downstream to the ultrasonic vibrator of the upstream It is characterized by making the cross-section configuration of the direction of a piping major axis of the wedge at least in one side of one pair of said transducers into 1/several the shape of a division circle or a division ellipse. Moreover, in the 2nd invention, it is characterized by attaching a taper to the point of the wedge at least in one side of one pair of said transducers.

[0008]

[Function] By elaborating the configuration of a wedge, the multiple echo of the supersonic wave within a transducer is lessened, tailing of a surroundings lump wave is decreased, and improvement in measurement precision is aimed at so that the reflected wave of the discharged supersonic wave may not carry out incidence to an ultrasonic vibrator.

[0009]

[Example] Drawing 1 is the block diagram showing the example of this invention, and a sectional side elevation and this drawing (b) of this drawing (b) are plans. this drawing -- setting -- 1 --

piping, 2a, and 2b -- a transducer and 3 -- an ultrasonic vibrator and 4 -- in a cable and 7, acoustic material and 10 show sound coupling material, and, as for a wedge and 5, 20 shows [a case and 6] the fluid, respectively. That is, it is filled up with packing (it is also called acoustic material) 7 like gum between that pars-convoluta-lobuli-corticalis-renis 4A and case 5, and this example is constituted while it attaches deflection to the point of a wedge 4 at the drawing 1 (**), as sign 4A shows. Without the reflected wave in pars-convoluta-lobuli-corticalis-renis 4A of a wedge 4 carrying out incidence to an ultrasonic vibrator 3, while a part of energy of the sound ray which carried out incidence to pars-convoluta-lobuli-corticalis-renis 4A with acoustic material 7 by carrying out like this absorbs sound, a multiple echo is repeated within a wedge 4 and it becomes the propagation to transducer 2b of a receiving side with the transmitting propagation wave of the reverse sense. Consequently, apparent propagation directivity not only improves, but since the multiple echo of the ultrasonic vibrator in a transducer decreases, tailing of the surroundings lump wave in piping 1 will decrease, and S/N of a received wave will improve.

[0010] The reason for attaching deflection to the point of a wedge 4 is explained with reference to drawing 2 . The sectional side elevation of a wedge and this drawing (b) of drawing 2 (b) are the plan. Moreover, the placing include angle of the supersonic wave of the ultrasonic vibrator [as opposed to the vertical line of a piping straight side shaft in thetat of this drawing (b)] 3, the sound ray which discharged u and t from the ultrasonic vibrator 3 by a certain pointing angle to piping straight side shaft orientations, and d show the outer-diameter dimension of an ultrasonic vibrator 3, and R shows the radius of a circle, or the focal distance of an ellipse, respectively. The configuration of a wedge 4 is a part of circle or ellipse (it is also called a division circle or a division ellipse), ultrasonic vibrator 3, it is located on the production of clamp-face 4B of the rust 4 which goes away, and is perpendicular to clamp-face 4B of a wedge 4, and the core of the circle or the focus of an ellipse is the division circle or division ellipse which has the line T passing through the outer-diameter location of an ultrasonic vibrator 3 in the range to the point P of crossing radii or an ellipse arc.

[0011] If it does in this way, since sound rays u1, u2, t1, and t2 will reflect the radial center line of a circle as a normal, the reflected wave of the sound ray which carried out incidence to the field shown with a sign A2 Without returning to an ultrasonic vibrator 3, with the propagation (facing the right) of the supersonic wave which goes to transducer 2b of a receiving side altogether, it becomes the reverse sense (facing the left), and only the supersonic wave in the field shown with a sign A1 will go to transducer 2b of a receiving side. For this reason, while the apparent propagation directivity of transmission improves, it is said that the multiple echo of the ultrasonic vibrator inside a transducer decreases, consequently generating of the surroundings lump wave of piping decreases, and S/N of a received wave improves.

[0012] Drawing 3 is the block diagram showing other examples of this invention, and a sectional side elevation and this drawing (b) of this drawing (b) are that plan. In addition, the sign given to each part is the same as drawing 1 . That is, the point which attached the taper to the point of a wedge is the description so that clearly [this example] also from this drawing (b). Between this taper section and case 5, it fills up with packing (it is also called acoustic material) 7 like gum like the case of drawing 1 , and absorbs sound in a part of energy of the sound ray which carried out incidence to the taper section with this acoustic material 7. The reason for attaching a taper to the point of a wedge is explained below with reference to drawing 4 .

[0013] Drawing 4 is the example which made the taper of a wedge point 120 degrees. In this drawing, the sound rays u and t discharged from the ultrasonic vibrator 3 in a transducer are reflected by wall 4C in a transducer, the propagation of the supersonic wave which goes to transducer 2b of a receiving side serves as reverse sense, and if the include angle of the sound ray in the plan of this drawing (b) is less than **30 degrees in the field shown with a sign A2, the propagation of the supersonic wave with which a sound ray goes to transducer 2b of a receiving side will serve as reverse sense altogether. Moreover, if the include angle of the sound ray in the plan of this drawing (b) is less than **30 degrees, only the sound ray of the field shown by the sign A1 and A3 will go to transducer 2b of a receiving side, the propagation directivity of the appearance of transmission improves, generating of the surroundings lump wave of piping will

decrease and S/N of a received wave will improve.
[0014] While making the taper of a wedge point drawing 5 at 90 degrees, the example which shifted the center position of a taper is shown. In this case, if the include angle of the sound ray in the plan of drawing 5 (b) is less than **45 degrees, only the sound ray of the field shown by the sign A1 and A3 will go to transducer 2b of a receiving side, and even when the directivity of the supersonic wave discharged from an ultrasonic vibrator 3 is not good, good transmission and reception will be attained. Since other points are the same as that of the case of drawing 2 or drawing 4 , it omits for details.
[0015] When attaching a taper to the point of a wedge, it can avoid that a reflective sound ray goes into an ultrasonic vibrator more certainly by taking into consideration the distance between an ultrasonic vibrator and the taper section. Drawing 6 is for explaining this and L shows the distance between an ultrasonic vibrator 3 and a taper point (reflective barrier 4C of a transducer). That is, if theta of drawing is set as the generating include angle of a side lobe, since most firing angles of the sound ray of an ultrasonic vibrator 3 are below generating include angles of a side lobe, it can reduce the multiple echo of the ultrasonic vibrator within a transducer sharply. In addition, relation like a degree type among distance L and theta is.
L=dand[Tanthetar+Tan(2theta r-theta)]/[1-Tan theta-Tan (2theta r-theta)] -- (1)
Here, thetar shows the setting include angle of reflective barrier 4C, d shows the outer-diameter dimension of an ultrasonic vibrator here, and it considers as 2theta r>theta.
[0016] The generating include angle theta of a side lobe changes with outer-diameter dimensions d of an ultrasonic vibrator, and has relation as shown in drawing 7 . The sign B of this drawing shows directivity and is shown by the 1st sort Bessel function. Moreover, Z is calculated from the formula shown all over drawing using theta, the outer-diameter dimension d of an ultrasonic vibrator, the wavelength lambda of the supersonic wave under wedge, etc. Moreover, the directivity B turns into a property as shown in drawing 8 . The sign Sdp of this drawing shows a side lobe. That is, the distance L of the ultrasonic vibrator 3 and taper point which are shown in (1) type can ask for the generating include angle theta of a side lobe with reference to drawing 8 from the outer-diameter dimension d of an ultrasonic vibrator 3, and can obtain it by calculating (1) type from this include angle theta.
[0017]
[Effect of the Invention] Since according to this invention the cross-section configuration of the direction of a piping major axis of a wedge where an ultrasonic vibrator is attached is made into a division circle or a division ellipse or the taper was formed in the point of a wedge While the apparent propagation directivity of a received wave improves and generating of the surroundings lump wave of piping decreases, the advantage whose accuracy of measurement the multiple echo within a transducer decreases, and whose tailing of the surroundings lump wave of piping decreases, consequently whose S/N of a received wave improves, and improves is acquired.

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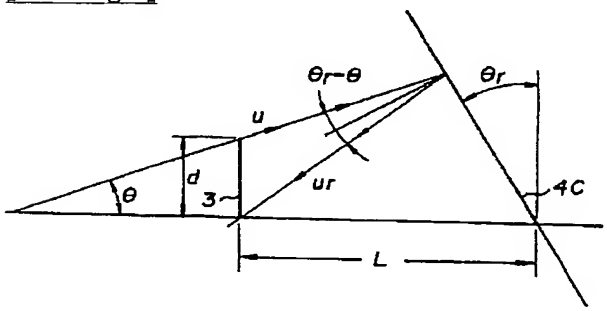
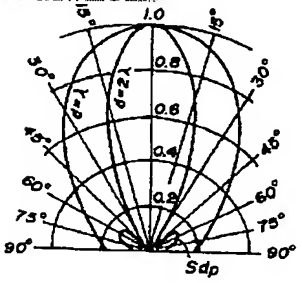
DRAWINGS

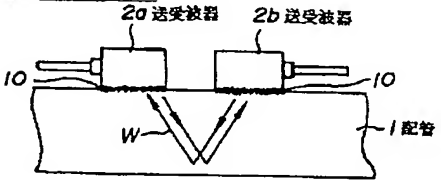
[Drawing 6]



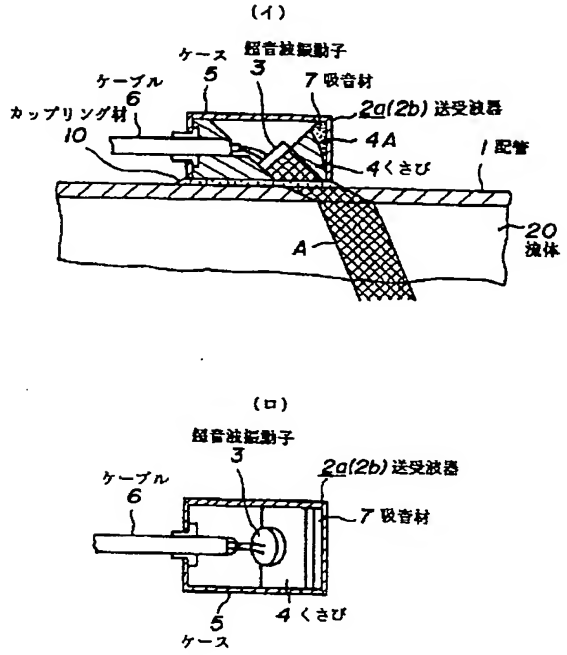
[Drawing 8]



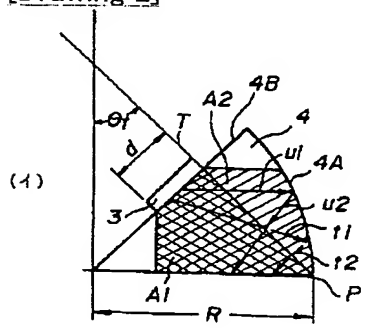
[Drawing 9]

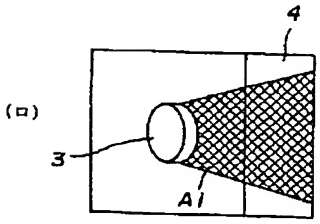


[Drawing 1]

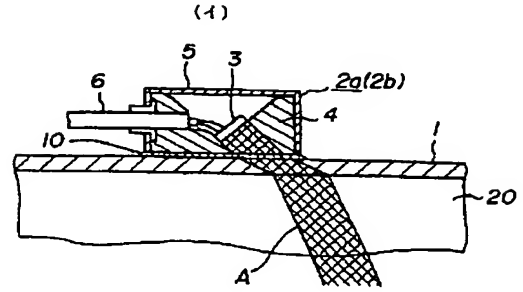


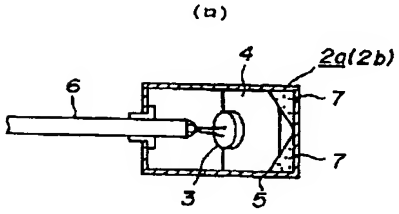
[Drawing 2]





[Drawing 3]





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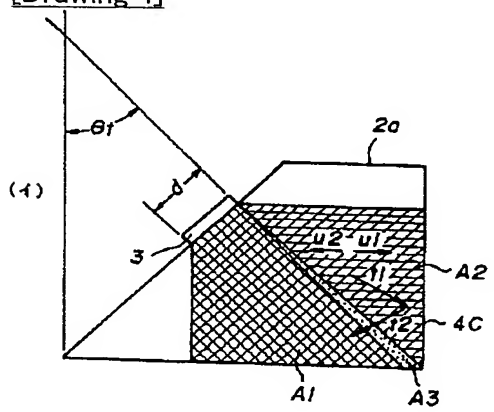
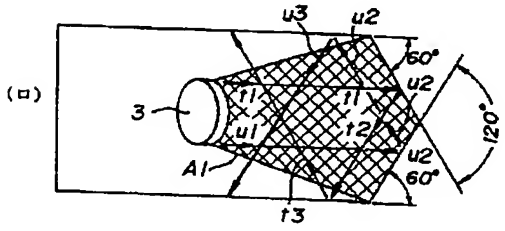
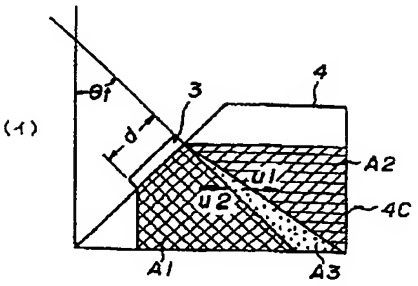
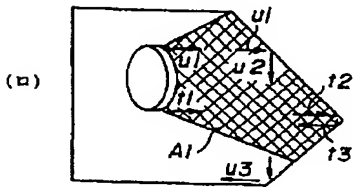




[Drawing 5]





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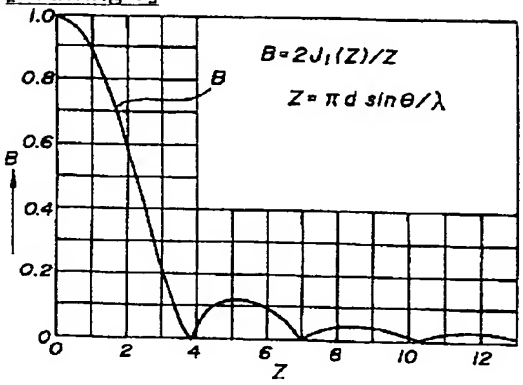
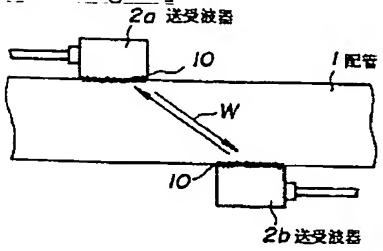
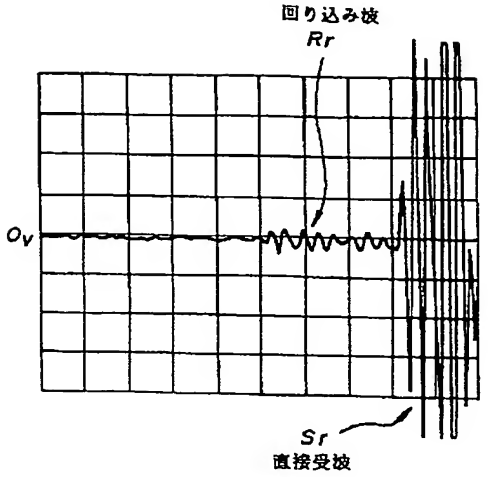


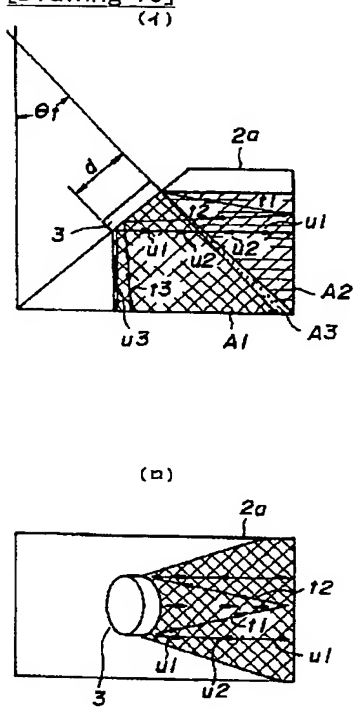
[Drawing 10]



[Drawing 11]



[Drawing 15]



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